UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
OREGON OPERATIONS OFFICE
805 SW Broadway, Suite 500
Portland, Oregon 97205

September 15, 2008

Mr. Robert Wyatt
Northwest Natural & Chairman, Lower Willamette Group
220 Northwest Second Avenue
Portland, Oregon 97209

Re: Portland Harbor Superfund Site; Administrative Order on Consent for Remedial Investigation and Feasibility Study; Docket No. CERCLA-10-2001-0240 – Commercial Diver Exposure Scenario for the Portland Harbor Risk Assessment

Dear Mr. Wyatt:

As you are aware, EPA proposed a commercial diver exposure scenario in our December 2, 2005 Identification of Round 3 Data Gaps memo. In our January 15, 2008 comments on the Comprehensive Round 2 Site Characterization and Data Gaps Report, EPA stated that a diver exposure scenario must be added to the human health risk assessment. Since that time, EPA and the Lower Willamette Group (LWG) have been discussing specific elements of the commercial diver exposure scenario. A final commercial diver exposure scenario that incorporates relevant LWG comments is attached to this letter.

Commercial diving activities are known to take place at the Portland Harbor site. EPA believes that the exposure parameters presented in the attached commercial diver exposure scenario are consistent with a "reasonable maximum exposure" approach. As a result, EPA directs the LWG to evaluate exposure to commercial divers in the baseline human health risk assessment according to the attached commercial diver exposure scenario.

If you have any questions, please contact Chip Humphrey at (503) 326-2678 or Eric Blischke (503) 326-4006. All legal inquiries should be directed to Lori Cora at (206) 553-1115.

Sincerely,

Chip Humphrey
Eric Blischke
Remedial Project Managers

cc: Greg Ulirsch, ATSDR
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September 15, 2008

Commercial Diver Exposure Scenario for the Portland Harbor Risk Assessment

The potential health risks for persons who dive in the Portland Harbor (PH) Superfund site will be evaluated as a part of the Human Health Risk Assessment (HHRA) for the PH Remedial Investigation (RI). This paper summarizes the method recommended for this evaluation by the human health risk assessors from EPA and its partners (Oregon Department of Environmental Quality – ODEQ – and the Oregon Department of Human Services).

In the Portland Harbor area, diving is done by several groups of people including: the public for recreation and gathering of biota for consumption; the sheriff's office for investigations and emergency activities; and, commercial divers for a variety of purposes, including marine construction, underwater inspections, routine operation and maintenance, and activities related to environmental work. The majority of divers are expected to be commercial divers.

Divers are expected to be exposed to contaminants in both sediments and water in the Portland Harbor Superfund site. Though there are methods to limit diver exposure to these contaminants[1] (e.g., dry suits, dry gloves, full face mask), these methods are not always employed. Divers in Portland Harbor have the option to use either wet or dry suits, wet or dry gloves, and a full face mask or a regulator held in the mouth with the diver's teeth. The reason for preferred use of wetsuits over dry suits is twofold: higher cost of drysuits versus wetsuits and river temperature. The Willamette River is 303d listed as a temperature impacted area with the Lower Willamette reaching average temperatures of over 70 degrees F in the summer months. EPA's experience (Sean Sheldrake, EPA dive team and site manager) is that most contractors on the Willamette River are still using wetsuits. As an example, both EPA's oversight contractor for the GASCO EE/CA and a diver working at the GASCO site noted that other divers at the site "definitely were not suited up or following the rigid health and safety requirements for the GASCO divers" and were wearing gear that "one would use for recreational diving in the tropics". In addition, EPA found that divers, hired by the Port of Portland's contractor, were wearing wet suits during T4 characterization activities (sediment trap placement). EPA directed the Port to ensure that appropriate, specific health and safety protocols were followed for the diver work as described in the letter referenced in footnote 1.

To evaluate the potential health risk for a commercial diver, information is needed on the level of contaminants in the exposure media (i.e., sediment and water) that the diver is being exposed to as well as information on the diver's behavior (e.g., type of equipment worn, frequency and duration of diving, years spent diving, and amount of inadvertent sediment ingestion) and diver's characteristics (e.g., body weight, surface area of the body).

For the PH risk evaluation for divers, data collected as a part of the PH RI and other studies are available to provide information on sediment and water contaminant levels that a diver might be exposed to. In the risk evaluation method described below, the information on diver behavior and characteristics is from a variety of sources.

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[1] Letter to LWG /Early Action Project Managers Regarding Diver HASP Protocol, 6/22/05 http://yosemite.epa.gov/R10/CLEANUP.NSF/6d62f9a16e249d7888256db4005fa293/31ae45c9c90a674988256e470062ced9/$FILE/Dive%20Safety%206%2022%202005.pdf

Superfund guidance recommends that exposure be evaluated for the "reasonable maximum exposure". For the diver scenarios, exposure is assumed to occur through four routes of exposure: dermal exposure from water, dermal exposure from sediment, inadvertent ingestion of water and inadvertent ingestion of sediment. Two scenarios have been selected for the RME. For the first scenario, referred to as the wet suit RME, a diver is assumed to be a commercial diver wearing a wet suit without a full face mask and wearing wet gloves or no gloves. Therefore, dermal exposure to water and sediment is assumed to occur over the entire body. For the second scenario, referred to as the dry suit neck dam scenario, a diver is assumed to be a commercial diver who wears a dry suit and hardhat attached through a neck dam rather than having a helmet mated to the dry suit. This diver is also expected to be wearing wet gloves. For this diver, dermal exposure to water and sediment is assumed to occur to the head, neck and hands. For both RME scenarios, inadvertent ingestion of water and inadvertent ingestion of sediment are assumed to be the same since both diver scenarios assume face exposure, wet gloves, and inadvertent exposure in the water and on the boat. A central tendency (CTE) scenario is also included assuming use of a wet suit without a full face mask and wearing wet gloves or no gloves. For the CTE scenario, the exposure routes are the same as that for the corresponding wet suit RME scenario but the exposure values have been reduced for some exposure parameters.

SEDIMENT EXPOSURE

Sediment Ingestion

For sediment ingestion by divers, the general equation for sediment ingestion for in-water fishers from the LWG's In-Water Technical Memorandum ("Technical Memorandum: Exposure Point Concentration Calculation and Approach and Summary of Exposure Factors" (April 21, 2006)) is used with one modification. The sediment contact frequency (SF) (time spent in one area) has been eliminated and the frequency of contact with sediment for a diver is now described with only one term, Exposure Frequency (EF) (days/year):

$$\text{Daily Intake (mg/kg/day)} = \frac{EPC * SIR * EF * ED * CF}{BW * AT}$$

Where:

EPC - Exposure Point Concentration (mg/kg)
SIR - Sediment Ingestion Rate (mg/day) [both RMEs (wet suit as well as dry suit with neck dam) 50 mg/day; CTE = 25 mg/day]
EF - Exposure Frequency (days/year) [both RMEs= 5 days/year; CT = 2 days/year]
ED - Exposure Duration (years) [both RMEs=25 years; CT=9 years]
CF - Conversion Factor (kg/mg) [10^{-6}]
BW - Body Weight (kg) [both RMEs /CTE = 70]
AT - Averaging Time (days) – [Cancer RMEs/CT=25,550 days; Non-cancer RMEs=9,125 days and Non-cancer CT=3,285 days].
It is expected that commercial divers could dive in any part of the near-shore PH site and, therefore, be exposed to near-shore contaminated sediment from areas throughout the site. As was done for in-water workers and for in-water fishers in the PH RI/FS Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report (Appendix F, Round 2 Human Health Risk Assessment, February 21, 2007) (Round 2 Report), the sediment EPC for divers would be derived for each near-shore half-mile segment (i.e., excluding the central navigation channel segment) on each side of the river. The 95% UCL on the arithmetic mean will be used

for the EPC for the reasonable maximum exposure (RME) scenario and the arithmetic mean will be used for the Central Tendency (CT) scenario.

In the above equation, the conversion factor (CF) and body weight (BW) recommended for divers would be that used for in-water adult fishers in the In-Water Technical Memorandum (Tables 22, 23, and 24). Therefore, for both the CT and RME it is assumed that body weight is 70 kilograms and that CF is kg/mg. The sediment ingestion rates chosen for divers are 50 mg/day for both RMEs and 25 mg/day for the CTE which are the values chosen for the in-water fisher scenarios in the In-Water Technical Memorandum and the Round 2 Report (Appendix F).

The recommended exposure durations for divers are 25 years for the RMEs and 9 years for the CT, which are EPA's national default exposure duration assumptions for workers. The averaging time (AT) corresponding to these exposure durations are 25550 days for cancer for both the RMEs and CT; and 9,125 days and 3,285 days for the RMEs and CT, respectively, for non-cancer.

The remaining parameter, exposure frequency (EF), was derived specifically for divers based upon EPA and LWG discussions with commercial divers and upon the experience of EPA divers who work in the PH Superfund site. Attachment A contains dive logs obtained by EPA for a commercial diver at Research Support Services, Inc. The first dive log is for his work at GASCO from May 5, 2005, until May 5, 2006, and the second for his work for Integral for several sites in PH from December 2004, to December 2005. For GASCO, he dove 74 times on 15 separate days. The number of dives per day ranged from 3 to 8. The average dive time was 24 minutes with a range from 5 minutes per dive up to 62 minutes per dive. For Integral, the diver dove 80 times on 20 separate days. The number of dives per day ranged from 2 to 6. The average dive time was 25 minutes with a range of 6 minutes per dive up to 85 minutes per dive.

Discussions that the LWG has had with dive companies also found that some commercial divers who perform work not related to sampling and analysis and remedial/removal activities (e.g., diving to repair outfalls, work on ship hulls, underwater inspections) do less dives per day but spend more time (up to 4 hours) underwater for each dive using surface supplied air. These dive companies also stated that they dive less frequently in Portland Harbor than do those divers who are diving for remedial/removal purposes.

Based upon the EPA and LWG information and using best professional judgement, the recommended exposure frequency for both RME divers is 5 days per year and 2 days per year for the CT.This exposure frequency assumes that all other diving done by a diver is done outside of Portland Harbor and, therefore, the diver is exposed to contaminants at only the one near-shore half-mile segment of the site for which an EPC is being calculated. Cumulative risk for divers who may dive at more than one site in Portland Harbor is not included in these calculations.

It is assumed that these assumptions will be protective for commercial divers that are performing routine activities but may underestimate the number of dives done in one segment for remedial/removal work. Workers conducting hazardous waste operations, including sampling/analysis and remedial/removal work, are not included in the Portland Harbor baseline risk assessment for current or potential future conditions. Instead, potential risks to remedial action workers should be included in an evaluation of implementation risks in a feasibility study. Also, remediation workers should be working under conditions that are in compliance with OSHA standards (29 CFR 1910.120). However, as previously discussed, EPA's experience is that divers in Portland Harbor involved in sampling/analysis are not always in compliance with

the OSHA standards. Typically, items such as basic diver environmental isolation/personal protective gear (PPE) and medical monitoring (1910.120 HAZWOPER items) are not proposed in the Health and Safety Plan, and are only added at the request of EPA. It is a reasonable presumption that contractors doing similar work not under EPA oversight are not equipping their divers, training their divers, or monitoring their divers for hazardous waste exposure per OSHA 1910.120. As a result, divers conducting hazardous waste operations and not following OSHA standards are likely exposed to risks similar to or greater than those being estimated for non-hazardous waste commercial divers in the PH HHRA. This is because these divers may spend more time diving in PH and dive in segments of the site that have some of the higher contaminant concentrations.

Sediment Dermal

For dermal exposure to sediment by divers, the general equation for dermal exposure to sediment from the LWG's In-Water Technical Memorandum is used with one modification. The sediment contact frequency (SF) (time spent in one area) has been eliminated and the frequency of contact with sediment for a diver is now described in with one term, Exposure Frequency (EF) (days/year):

$$\text{Daily Intake (mg/kg/day)} = \frac{EPC * SA * AF * ABS * EF * ED * CF}{BW * AT}$$

For divers, the recommended EPC, EF, ED, CF, BW, and AT are the same as those described above for sediment ingestion:

EPC - Exposure Point Concentration (mg/kg) [By segment]
EF - Exposure Frequency (Events or days/year) [both RMEs=5 days/year; CT=2 days/year]
ED - Exposure Duration (years) [RME=25 years; CT=9 years]
BW - Body Weight (kg) [70 kg]
AT - Averaging Time (days) – [Cancer RMEs/CT=25,550 days; Non-cancer RMEs=9,125 days and Non-cancer CT=3,285 days].
CF - Conversion Factor (kg/mg) [10^{-6}]

For ABS, AF and SA, the following values are recommended:

(1) Absorption factors (ABS, unitless) are chemical-specific and provided in Table 25 of the In-water Technical Memorandum.

(2) Adherence Factors (AF) -For adherence factors (AF, mg/cm^2), it is assumed that the AFs for divers are the same as those for in-water fishers in the In-water Technical Memorandum: 0.3 mg/cm^2 for both of the RMEs and 0.07 mg/cm^2 per event for the CT.

(3) Surface Area (SA)- For surface area (SA, cm^2) for the wet suit RME diver and the wet suit CT divers who are assumed to be wearing a wet suit and to have whole body exposure, the surface area exposed would be 18,150 cm^2 (average of the 50% for males and females). For the dry suit with neck dam RME exposure, only hands, head and neck would be exposed. This is equivalent to a surface area of approximately 2,510 cm^2 This is based upon 1,206 cm^2 for the head and 904 cm^2 for hands based on the average of the 50% for males and females. A value of 330 cm^2 was a used for the neck based upon 5% of the trunk value (including neck) of 6,600 cm^2 (the average of the 50% value for males and females from EPA's Exposure Factors Handbook)

WATER EXPOSURE

Water Ingestion

For inadvertent surface water ingestion by divers, use of the general equation for inadvertent surface water exposure for adult recreational beach users (i.e., swimmers) from the LWG's In-Water Technical Memorandum is used:

$$\text{Daily Intake (mg/kg/day)} = \frac{EPC * WIR * t_{ev} * EF * ED * CF}{BW * AT}$$

For EF, ED, BW, and AT, the values for divers are the same as those recommended for diver exposure to sediments:

EF - Exposure Frequency (Events or dives/year) [both RMEs=5 days/year; CT=2 days/year]
ED - Exposure Duration (years) [RME=25 years; CT=9 years]
BW - Body Weight (kg) [70 kg]
AT - Averaging Time (days) – [Cancer RMEs/CT=25,550 days; Non-cancer RMEs=9,125 days and Non-cancer CT=3,285 days].
CF – Conversion Factor (L/ml) [10^{-3}]

For the EPC, t_{ev}, and WIR, the following values are recommended:

(1) EPC - Exposure Point Concentration (mg/L) - For the EPC for adult recreational swimmers in LWG's In-Water Technical Memorandum, humans are assumed to swim recreationally in a limited number of areas in the river where there are parks or where they have easy access to beach areas. Commercial divers, however, can be exposed to waters in the Willamette River that are near industrial sources as well as in recreational areas. Therefore, for divers, all of the surface water data collected in the PH site should be considered for use in calculating the EPC for divers, including both near-bottom and integrated water column data collected at specific sites, individual transect data, and data collected in quiescent areas.

For divers, surface water COPCs should be selected by screening the maximum of any surface water sample against the EPA Regional Screening Levels. For surface water data from transect sampling, transect EPCs should be calculated as described in Attachment 1 (*Summary of Surface Water Transect Data to be Used for Transients and Divers*). For the calculation of cumulative cancer risks and non-cancer hazards for divers from dermal exposure to and ingestion of sediments and surface water using transect data, divers between each transect should be assumed to be exposed to the closest transect surface water upstream of the ½ mile sediment segment (e.g., for sediment segments between RM 6.5 to 11, transect data from RM 11 would be used). Surface water data are also available as single point samples from Round 2 sampling in several areas of the river and as near bottom and near surface samples from Round 3 sampling in parts of the river. For the Round 3 samples, the near bottom and near surface samples should be averaged and used as the EPC for divers. For the calculation of cumulative cancer risks and non-cancer hazards for divers from dermal exposure to and ingestion of sediments and surface water using single point stations, the surface water samples within that ½ mile sediment segment should be used following the data rules agreed to for the HHRA. For the summary table of cumulative cancer risk and non-cancer hazards (e.g., Table 5-59, Appendix F in the Round 2 Report), the highest cumulative risk for divers should be presented.

(2) WIR - Water Ingestion Rate (mL/hour) - For the water ingestion rate, the value of 50 ml/hour is used for both the CT and RME recreational beach users (swimmers) in the In-water Technical Memorandum. This same value is recommended for divers based upon discussions with EPA divers.

(3) t_{ev} – Event Duration (hr/event or dives) - For developing values for event duration, the dive logs discussed above were used as well as information collected by the LWG by interviewing diving companies. From the GASCO early-action remediation dive logs, the average dive time was 24 minutes with a range of 5 minutes per dive up to 62 minutes per dive. From the Integral dive logs, the average dive time was 25 minutes with a range from 6 minutes per dive up to 85 minutes per dive. The range of time spent in the water in a day is, therefore, from 50 minutes (2 dives times 25 minutes per dive) to 3.2 hours (8 dives times 24 minutes per dive). The LWG found that a diver can spend 4 hours in the water in one day using supplied air. Based upon these data, the recommended values for the event duration (for each day) are 2 hours/dive for the CT (approximate mid-range of 50 minutes and 3.2 hours) and 4 hours/dive for both of the RMEs (information from the LWG surveys).

Water Dermal

For dermal exposure for divers to surface water, the general equation for surface water exposure for adult recreational beach users (i.e., swimmers) from the LWG's In-Water Technical Memorandum is used:

$$\text{Daily Intake (mg/kg/day)} = \frac{DA * SA * EF * ED}{BW * AT}$$

For all of the exposure parameters, except DA (the absorbed dose per event in mg/cm^2 per event (i.e., per day), the values for divers are the same as those recommended for dermal exposure to sediment:

EF- Exposure Frequency (Events or dives/year) [both RMEs=5 days/year; CT=2 days/year]
ED - Exposure Duration (years) [RME=25 years; CT=9 years]
BW- Body Weight (kg) [70 kg]
AT - Averaging Time (days) – [Cancer RMEs/CT=25,550 days; Non-cancer RMEs=9,125 days and Non-cancer CT=3,285 days].

(1) Surface Area (SA)- As with dermal exposure to sediments, the surface area exposed (SA, cm^2) for the wet suit RME diver and the wet suit CT divers who are assumed to be wearing a wet suit and to have whole body exposure is assumed to be 18,150 cm^2 (average of the 50% for males and females). For the dry suit with neck dam RME exposure, only hands, head and neck would be exposed. This is equivalent to a surface area of approximately 2,510 cm^2. This is based upon 1,206 cm^2 for the head and 904 cm^2 for hands based on the average of the 50% for males and females. A value of 330 cm^2 was used for the neck based upon 5% of the trunk value (including neck) of 6,600 cm^2 (the average of the 50% value for males and females from EPA's Exposure Factors Handbook).

(2) Absorbed Dose (DA) - Several of the values used to calculate DA (the absorbed dose per event in mg/cm^2 per event (i.e., per day)) are chemical specific and are found in "Supplemental Guidance for Dermal Risk Assessment" (Part E of Risk Assessment Guidance for Superfund,

August 16, 2004). As discussed above for water ingestion, t_{ev}, event duration (hr/event or dives), is 2 hours/dive for the CT (approximate mid-range of 50 minutes and 3.2 hours) and 4 hours/dive for both of the RMEs. Further discussion is needed with the LWG to determine how best to address some of the uncertainties in the DA values for selected chemicals (e.g., discussing the uncertainties in the Kp value used to derive DA, the absorbed dose per event for dermal exposure to water).